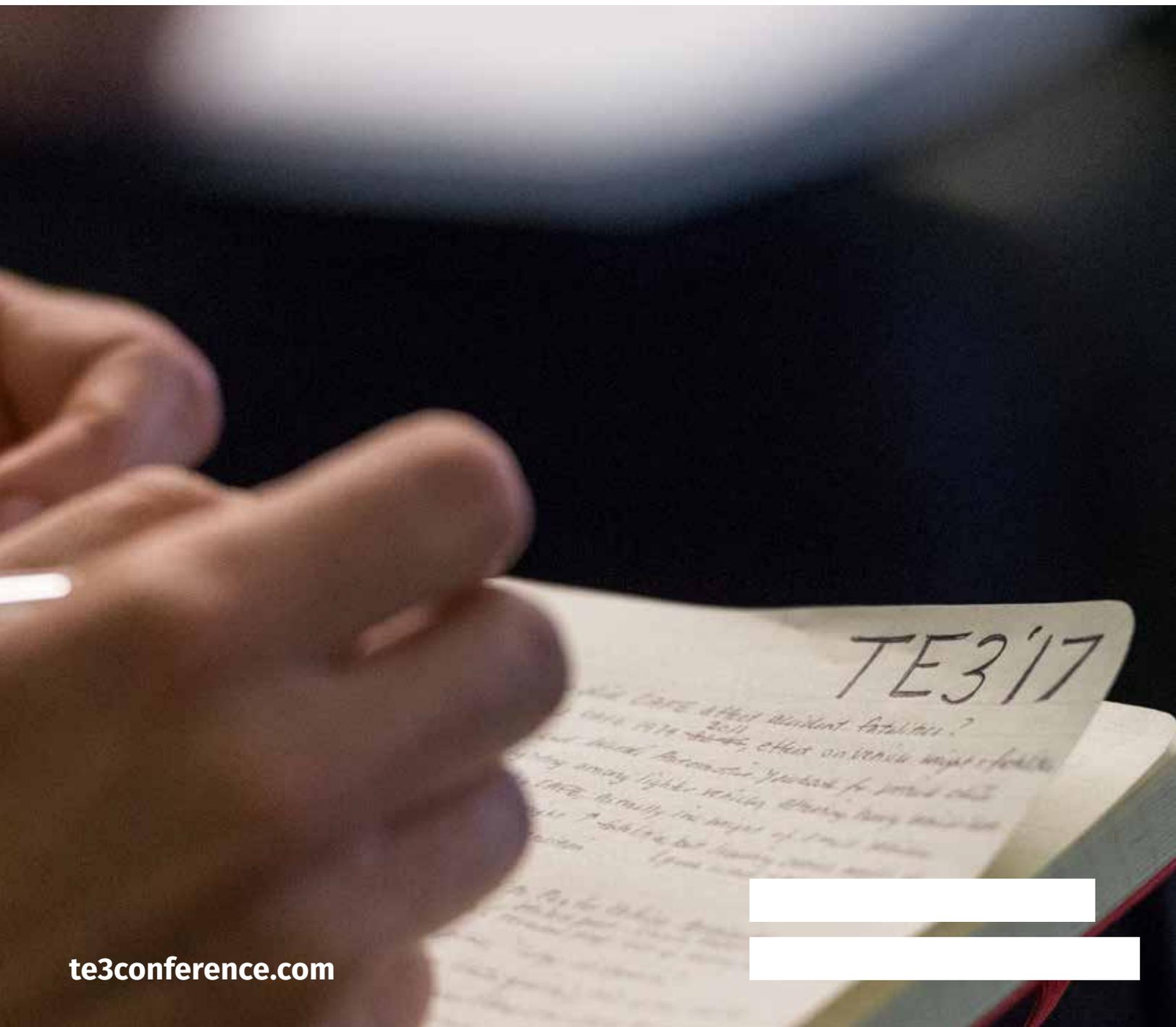


University of Michigan
Conference on
**Transportation, Economics,
Energy, and the
Environment**

October 20, 2017



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ABOUT TE³

The Transportation, Economics, Energy and the Environment (TE³) conference brings economic scholars together with government and industry practitioners to exchange ideas and strengthen the collective knowledge for addressing transportation energy and environmental policy challenges.

Held on October 20, 2017, the 4th annual TE³ conference hosted over 140 people from academic institutions, mobility, energy and financial firms, public agencies, nonprofit organizations and consultancies interested in energy and transportation. The one-day event consisted of three sessions with presentations and discussions of peer-reviewed papers, and two panel discussions addressing current policy issues related to the topic.



OPENING REMARKS

The conference was convened by its co-chairs, **John DeCicco**, a Research Professor at the University of Michigan Energy Institute (UMEI), and **Ellen Hughes-Cromwick**, Senior Economist and Interim Associate Director of Social Science and Policy at UMEI.

DeCicco welcomed the audience and thanked them, the paper authors and other program participants for their interest and contributions. He highlighted the importance of economics as policymakers continue to wrestle with how to meet the mobility needs of consumers at acceptable cost while addressing energy-related concerns, including the major environmental challenge of global warming. He noted that, even though the country

is in a distinctive phase of its political and policy cycle, these challenges are perennial, and that economic analysis remains crucial for guiding society on how to best allocate resources in any given area.

Hughes-Cromwick pointed out the benefit of collaboration between academia, industry, and government, emphasizing the need for interdisciplinary discussion to solve complex problems. She thanked the conference sponsors, acknowledging their support for energy-related research, and welcomed the student participants, a number of whom had flown in from around the country and were able to attend because of special support from the Sloan Foundation.



AGENDA

8:45 — 9:00 Welcome, **John Decicco** and **Ellen Hughes-Cromwick**, University of Michigan Energy Institute

9:00 — 10:30 **Paper Session #1:**
Trade-Offs Among Vehicle Attributes

SESSION CHAIR: **William Chernicoff**, Toyota Mobility Foundation

“The Effect of Fuel Economy Standards on Vehicle Weight Dispersion and Accident Fatalities”

Antonio Bento (University of Southern California), **Kenneth Gillingham** (Yale University), **Kevin Roth** (University of California, Irvine)

Presenting Author: **Kenneth Gillingham**

“Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?”

David Greene (University of Tennessee, Knoxville), **Anushah Hossain** (University of California, Berkeley), **Julia Hofmann** (RTI International), **Gloria Helfand** (U.S. Environmental Protection Agency), **Robert Beach** (RTI International)

Presenting Author: **David Greene**

“How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption”

Benjamin Leard (Resources for the Future), **Joshua Linn** (Resources for the Future), **Yichen Christy Zhou** (Resources for the Future and Clemson University)

Presenting Author: **Benjamin Leard**

10:50 — 11:20 **Discussion of Paper Session #1**

Discussants:

James Sallee, Assistant Professor, Department of Agricultural and Resource Economics, University of California, Berkeley

Shannon Baker-Branstetter, Energy and Environment Policy Counsel for Consumers Union

11:20 — 12:10 **Panel Discussion A:**
Economics and social dimensions of Emerging Mobility Systems

MODERATOR: **Ellen Hughes-Cromwick**, University of Michigan Energy Institute

Panel Discussion Members

Fellipe Balieiro, Senior Consultant, Oil Markets, Midstream & Downstream, IHS Markit

Alexander Keros, Director, GM Urban Mobility and Maven Public Policy, General Motors

Rod Lache, Managing Director, Deutsche Bank Securities

Neil Schloss, Vice President and Chief Financial Officer, Ford Mobility LLC

Qiang Hong, Senior Research Scientist, Transportation Systems Analysis Group, Center for Automotive Research

1:25 — 2:40 **Paper Session #2:**
Electric Vehicles

SESSION CHAIR: **Ryan Kellogg**, University of Chicago

“Network Externality and Subsidy Structure in Two-Sided Markets: Evidence from EV Incentives”

Katalin Springel (University of California, Berkeley)

Presenting Author: **Katalin Springel**

“Do Electric Vehicles Need Subsidies? A Comparison of Ownership Costs for C/H/EVs”

Hanna Breetz (Arizona State University), **Deborah Salon** (Arizona State University)

Presenting Authors: **Hanna Breetz** and **Deborah Salon**

Discussants:

Joshua Cregger, Technology Policy Analyst, U.S. Department of Transportation Volpe Center

Stephen Holland, Associate Professor, Department of Economics, Bryan School of Business and Economics, University of North Carolina at Greensboro

3:00 — 3:40 **Paper Session #3:**
The Structure of Fuel Markets

SESSION CHAIR: **Sam Stolper**, University of Michigan

“Fuel Subsidy Pass-Through and Market Structure: Evidence from the Renewable Fuel Standard”

Gabriel Lade (Iowa State University), **James Bushnell** (University of California, Davis)

Presenting Author: **Gabriel Lade**

Discussant:

Michael Leister, Senior Associate, Stillwater Associates

3:40 — 4:30 **Panel Discussion B:**
Infrastructure Finance for Existing and Emerging Mobility Systems

MODERATOR: **John Decicco**, University of Michigan Energy Institute

Panel Discussion Members

Asha Weinstein Agrawal, Director, MTI National Transportation Finance Center and Professor, Department of Urban and Regional Planning, San Jose State University

Mary Zimmerman, Director, Office of Transportation Policy Studies, U.S. DOT Federal Highway Administration

Jim Tymon, Chief Operating Officer / Director of Policy and Management, AASHTO

PAPER SESSION #1:

Trade-offs Among Vehicle Attributes

“CAFE can have positive net benefits from reduced fatalities alone.”

Kenneth Gillingham

The first technical session of TE³ 2017 was moderated by **William Chernicoff** of the Toyota Mobility Foundation. It focused on vehicle attributes related to fuel economy, including vehicle size, weight, safety and performance. The papers and discussion addressed how these attributes interact with one another and with market and policy influences.

Kenneth Gillingham of Yale University presented “The Effect of Fuel Economy Standards on Vehicle Weight Dispersion and Accident Fatalities.” The work was motivated by earlier studies claiming an adverse impact from Corporate Average Fuel Economy (CAFE). Previous research had produced a wide range of estimates, but no one had fully traced how the regulation influences the chain of effects that might lead to higher fatalities. Gillingham and his co-authors used U.S. vehicle fleet data dating from 1948, enabling them to characterize the evolution of the fleet prior to CAFE standards, and examined accident data over 1995-2009.

Gillingham said their analysis found that domestic automakers met CAFE standards by decreasing the weight of their smaller cars. Such an effect increased weight dispersion, which by itself would increase traffic fatalities, but they found that lower mean fleet weight lowered overall fatalities. Their model estimated that approximately 400 lives have been saved relative to a counterfactual scenario without CAFE standards, leading to a conclusion that the CAFE standards offered positive net benefits from the reduced fatalities alone.

David Greene of University of Tennessee, Knoxville, presented “Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?” This study involved a meta-analysis of 52 economic studies of the topic published between 1995

and 2015. Although the studies infrequently reported willingness-to-pay (WTP) estimates, it was generally possible to infer WTP values from the coefficients reported. Greene addressed the challenges of calculating WTP due to the varying objectives and diverse approaches that various studies had used. Their analysis found large differences in the estimates for many attributes, notably the willingness to pay for a reduction in per-mile fuel costs, but less variability in the estimates for others, such as vehicle acceleration ability.

Greene then offered suggestions for how researchers could improve WTP estimation in the future. Responding to a question, he noted that the uncertainty in WTP estimation is so large that, in most cases one can argue the effect one way or another. He also pointed out that consumers do not make decisions based on a continuous trade-off or by maximizing utility over all of the many attribute-related variables.

Benjamin Leard of Resources for the Future presented “How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adaptation.” Using new vehicle buyer survey data for 2009-2014 plus data starting in 1996 on prices, vehicle fuel economy, technology and other characteristics, Leard and his coauthors homed in on the interaction between acceleration performance and fuel economy. They found that this tradeoff occurred to

“Consumers do not act like economists when they go to buy vehicles.”

Shannon Baker-Branstetter

different degrees and at different times for cars and light trucks. Trucks saw horsepower gains emphasized over fuel economy prior to 2005, while cars saw relatively greater horsepower gains prior to 2012. Overall, Leard et al. found that consumers have a high willingness to pay for performance but undervalue fuel economy with an implied discount rate of about 13 percent. Accounting for this tradeoff

implies that CAFE standards have a negligible net effect on consumer welfare.

Discussants **James Sallee** of University of California, Berkeley, and **Shannon Baker-Branstetter** of Consumers Union then offered their thoughts on the three papers and the general topic of the morning session. Among the issues they raised were bundling of features, impacts of policy on technology adoption and perspectives on the safety concerns.

Sallee cited compact fluorescent lightbulbs as an example of how consumers can show low interest in a technology that passes a cost-benefit test when other attributes of the technology come into play. A weak consumer response to a nominally cost-effective energy technology need not imply a failure of rationality or undervaluation of energy efficiency. He said that all three papers show how considering other attributes is critical when evaluating consumer and regulatory decisions about fuel economy.

Praising Greene et al. for their “frontal assault” on the issue, Sallee suggested that future meta-analyses should give more weight to studies that have the best empirical design. Remarking on the paper by Gillingham et al., he noted limitations of the historical data they used and pointed out that higher fatalities due to increased driving (the fuel economy rebound effect) would overwhelm their finding of safety benefits from higher CAFE standards. Regarding the Leard et al. paper, Sallee was skeptical that consumers undervalue fuel economy but noted that other rationales could be used to justify aggressive CAFE standards.

Baker-Branstetter discussed consumer behavior and decision-making related to vehicle purchases, pointing out that the average consumer does not behave like an economist. She noted that new car buyers are wealthier than average while most consumers purchase used cars. Higher consumer spending on vehicles over the past decade reflects how wealthier consumers tend to buy larger cars with more luxury features. Consumer satisfaction surveys sug-



gest that higher horsepower provides diminishing value to buyers, while fuel economy is an attribute that consumers want to see improved in their next vehicle purchase.

Baker-Branstetter also pointed out that automakers have many options and great flexibility for complying with vehicle standards. She noted that for fuel economy, safety and many other features, automakers do not offer *a la carte* pricing, but rather bundle attributes together. Given this reality of car marketing, it is difficult to discriminate econometrically among attribute preferences. Regarding safety and vehicle size, Baker-Branstetter said that such concerns were a reason to ensure that light truck standards are increased at least the same rate, if not faster, than car standards.

The session concluded with a panel-style Q&A session in which the three authors and two discussants responded to audience questions expanding upon and clarifying the studies presented.

PANEL DISCUSSION A:

Economics of Emerging Mobility Systems

The morning round of sessions concluded with a discussion of the economics of emerging mobility systems, focusing on the future of mobility in U.S. cities and emphasizing electric and autonomous vehicles. The session was moderated by **Ellen Hughes-Cromwick** of the University of Michigan Energy Institute and featured:

Fellipe Balieiro: Senior Consultant, Oil Markets, Midstream & Downstream, IHS Markit

Qiang Hong: Senior Research Scientist, Center for Automotive Research

Alexander Keros: Director, GM Urban Mobility and Maven Public Policy, General Motors

Rod Lache: Managing Director, Deutsche Bank Securities

Neil Schloss: Vice President and Chief Financial Officer, Ford Mobility, LLC

Hughes-Cromwick began the session by observing that, as a society, “we’ve been here before, at a crossroads of new automotive technology, new business models, new fuels, and the mantra ‘this time is different.’” She then asked the panelists to each give short summaries of their views on the future of mobility and whether progress in new mobility will be accelerated by the advent of new technology, or dominated by continued improvements to the conventional internal combustion engine vehicles.

Neil Schloss began by classifying mobility as a right, rather than a commodity to be purchased, emphasizing a future that includes a mix of transportation methods to increase the accessibility of transportation for all. Although trends in new technology adoption will vary globally, he felt that



“As a result of the need to control congestion, we would expect the evolution of autonomous vehicles ... to be much more rapid in China and India.”

Fellipe Balieiro

they would likely be faster than initial predictions projected. Schloss highlighted the themes that he believes will influence the future mobility, including smart technology, data access, regulatory structure and costs.

Alex Keros started his remarks with the story of his two children learning to ride bikes for the first time, pointing out the key role of consumer motivation with regard to mobility. He likened mobility to freedom and noted that cities will influence the level of access to mobility as they develop and evolve. Keros commented on the utility of shared mobility for solving the problem of expanding access for all, and noted that cities are beginning to prioritize access over decreasing the overall cost of vehicles.

Rod Lache brought in a financial perspective by comparing current cost estimates of electric and gasoline vehicles. An electric vehicle’s essential components now cost around \$15,000 to \$17,000 while those of internal combustion vehicles cost about \$3,500 to \$5,000. He believes that, as battery costs decline, convergence will likely occur around 2030, after which battery-electric powertrains will be less costly to produce than internal combustion powertrains. Lache described how consumers may find it cheaper to use ride-hailing services rather than owning private vehicles,

and noted that investors have begun investigating the best ways to allocate capital for shared mobility business models.

Qiang Hong raised a public policy perspective, stressing the challenge of balancing technology advancement with long-term public investments. He identified local communities as the most active in addressing this challenge, observing that they are grappling with how technology evolution is likely to affect their long-term investment in transportation infrastructure. Hong compared the convergence rates in developed and developing countries, specifically with regard to adoption of autonomous vehicles over private vehicles, and noted how developing countries are likely to show faster adoption of shared mobility services enabled by connected vehicle technology.

Fellipe Balieiro expanded on previous comments by predicting that driverless technology would greatly change the mobility system as it is today, and noted that research and development efforts from mobility and ride-sharing companies would become very influential over the coming two or three decades. He described a shift in the ownership model, away from personal ownership as costs decline for ride-sharing services, and highlighted differences in social and cultural norms as a factor that would affect rates of technology adoption among countries.

The panel session concluded with an audience Q&A and discussion, featuring topics such as the rate at which electric and autonomous vehicles will enter the fleet, costs of ownership and technology development, changes to the structure of the automotive and mobility industries, and changes to city infrastructure needed in order to accommodate changes in fleet makeup.

To view all available conference videos, papers and presentations, see the **2017 TE³ Conference Archive**.

PAPER SESSION #2:

Electric Vehicles

“On the back of an EV it says zero emissions vehicle, but of course that’s not really true because you can think of it as having a long tailpipe; the power plants are the emissions.”

Stephen Holland

The first afternoon session was moderated by **Ryan Kellogg** and consisted of two paper presentations on electric vehicle subsidies and benefits, followed by a discussion.

The first paper, titled “Network Externality and Subsidy Structure in Two-Sided Markets: Evidence from EV Incentives,” was presented by **Katalin Springel** of Resources for the Future. Using Norway as a case study, Springel examined whether electric vehicle (EV) sales are more influenced by subsidizing charging stations or by subsidizing the vehicles themselves to lower consumer EV purchase costs. She found that charging station subsidies and consumer price incentives both had significant positive impacts on EV sales. A \$1,200 subsidy per charging station raised vehicle sales by 8.4 percent while a \$1,200 increase in the subsidy per vehicle raised vehicle sales by 3.1 percent. Springel also found that station subsidies see diminishing returns at a much faster rate than vehicle price subsidies as the network becomes saturated with charging stations.

Deborah Salon and **Hanna Breetz** of Arizona State University jointly presented their paper, “Do Electric Vehicles Need Subsidies?” Their research involved a comparison of ownership costs for conventional, hybrid and electric vehicles, and it examined two questions: first, whether and when fuel savings balance out capital costs, and second, the extent to which battery electric vehicles (EVs) depend on subsidies to be cost-competitive for consumers.

Breetz said that on average across the 14 cities they analyzed, an EV was significantly more expensive over a five-year period than either a comparable non-plug-in hybrid electric vehicle (HEV) or a conventional vehicle (CV) that has only an internal combustion engine. An EV only began to approach cost parity in states that offered subsidies in addition to the federal subsidy.

Salon described their sensitivity results, presenting scenarios for Los Angeles that involved different depreciation rates, miles of driving and ownership periods. She concluded that, for a typical owner, fuel savings are unlikely to offset the higher costs of an EV even if gasoline prices are high and electricity prices are low, indicating that EV cost competitiveness is very dependent on subsidies.

Discussants **Joshua Cregger** of the Volpe National Transportation Systems Center and **Stephen Holland** of the University of North Carolina at Greensboro then offered their thoughts.

Cregger noted that the contrasting success of EVs in Norway and the United States may be related to differences in culture and geography. He also commented that consumers who purchase used EVs benefit from the high depreciation rate, but that the original owners must still be subsidized before used EVs can become available to second owners, which again underscores the need for incentives.

Holland raised a question about the merits of subsidizing EVs in light of their actual benefits, remarking that EVs have “a long tailpipe” and that their environmental value depends on the locale where they are used. He said that neither paper addressed the crucial question of whether it is worthwhile to subsidize EVs. Noting that the effort being made to solve the “chicken and egg” problem of EVs and charging stations is only worthwhile if there are net environmental cost benefits, Holland said that his takeaway was that existing subsidies are too large and that even larger subsidies are not justified by current environmental benefits.

“EVs don’t really make sense anywhere economically ... it’s not really about fuel savings. It’s about how you affect net capital costs through subsidies.”

Hanna Breetz

During the Q&A segment with the audience, David Greene sparked a discussion by pointing out that debating the current environmental benefits of EV subsidies is shortsighted because the benefits are, by nature, long-term. Referencing a National Research Council study, he

said that if EV costs converge with those of conventional vehicles over time, then the benefits of a transition to a largely electric fleet would be roughly an order of magnitude greater than the cost of the subsidies. Deborah Salon agreed and noted that, even though their paper examined only current consumer costs, EVs had benefits for a number of other reasons, such as energy security, macroeconomic stability and reducing the vulnerability to oil price spikes, in addition to their environmental benefits.

The remaining discussion touched on topics such as the similar maintenance costs between electric and gasoline vehicles in the first five years, factors affecting depreciation, other issues related to total cost of ownership, and the factors that can shape vehicle policy beyond environmental concerns.



PAPER SESSION #3:

The Structure of Fuel Markets

The third paper session, moderated by **Samuel Stolper** of the University of Michigan School of Environment and Sustainability, explored the structure of fuel markets and the effects of a policy that requires increasing use of biofuels for transportation.

Gabriel Lade presented the paper he wrote with co-author **James Bushnell**, “Fuel Subsidy Pass-Through and Market Structure: Evidence from the Renewable Fuel Standard.” They examined whether the Renewable Fuel Standard (RFS) is working as intended, i.e., how well compliance with the regulation imposed on upstream fuel suppliers resulted in the transmission of a price signal to downstream consumers as a way to increase ethanol demand. Because ethanol blending has been saturated at the 10% level (“E10”) since 2013, a critical question is whether the RFS compliance mechanism is creating an adequate subsidy for higher blends (E15 to E85). The market structure involves three main levels. The upstream level includes petroleum product refiners, who are subject to the RFS regulation, and ethanol producers. The next level comprises wholesale fuel terminals, where fuels are blended, and the final downstream level includes retail outlets where consumers purchase fuel.

Lade and Bushnell analyzed wholesale costs, as affected by the RFS, and retail fuel prices using weekly data for 451 motor fuel stations in three states over a 2013-2016 period. They found an E85 subsidy pass-through of 50% to 80% and that full pass-through took 6-8 weeks, implying that the policy is working as intended to generate a downstream price signal for motivating consumers to buy E85. They also found large heterogeneity in the extent of pass-through among stations, with significantly greater E85 subsidy pass-through in areas where stations were clustered; i.e., where there was greater retail competition.

Michael Leister of Stillwater Associates, a fuels industry consultancy, served as the discussant for the session. He agreed that the RFS appears to be working as intended, but that it is a very expensive policy. He noted that, in many

cases, E85 is not blended at terminals as modeled by Lade and Bushnell, but rather produced directly at the ethanol plant and then taken to the terminal already blended. He also noted that the price data they used does not reflect compliance obligations traded by large refiners, which account for the majority of RFS compliance. Leister also pointed out that the majority of E85 is not sold on an energy-equivalent basis with E10 (i.e., that it is overpriced in terms of the useful fuel energy provided to drivers); to encourage greater use, E85 would need to be sold below the price of regular gasoline (E10).

Samuel Stolper began the Q&A discussion by asking if there had been an increase in the number of vehicles that can use E85 (i.e., flex-fuel vehicle, FFVs). Leister replied that the CAFE loophole that encouraged FFV sales is being taken away, a situation that could discourage E85 use even as the RFS mechanism was working to encourage E85 demand. Lade noted that even though the number of FFVs had declined, E85 sales were so price sensitive that its use could be significantly boosted if the RFS subsidy pushed its price sufficiently below the price of E10.

Leister noted that the base market for E85 consists of price-insensitive customers, so that at current low E85 sales levels, it is not in a station owner’s interest to lower the price of E85. This situation works against the need for lower, energy-parity prices to motivate other consumers to choose E85.

A final question asked whether pass-through was affected by the need for station owners to recover pump costs. Both Lade and Leister said that that was unlikely, but for differing reasons. Lade felt that such fixed costs should not come into play in a competitive market. Leister pointed out that, because E85 sells so slowly, it depresses station owners’ margins and is not helpful for recovering infrastructure costs. Therefore, they are unlikely to buy new pumps or tanks based on E85 sales, but rather must rely on high-volume standard fuel and convenience store sales to recover any such investment costs.

PANEL SESSION B:

Infrastructure Finance for Existing and Emerging Mobility Systems

This final session of the conference focused on the challenges of financing the infrastructure for existing and future transportation systems. It addressed issues including timelines for infrastructure change, public and private mobility pricing options and the potential shift from personal vehicle ownership to mobility services. Moderated by John DeCicco of the University of Michigan Energy Institute, the panel featured:

Asha Weinstein Agrawal: Director of the National Transportation Finance Center at the Mineta transportation Institute and Professor of Urban and Regional Planning, San Jose State University

Jim Tymon: Chief Operating Officer and Director of Policy and Management, American Association of State Highway and Transportation Officials

Mary Zimmerman: Director, Office of Transportation Policy Studies, Federal Highway Administration, U.S. Department of Transportation

For the first portion of the panel, Zimmerman discussed how transportation economics might be affected by technology changes, and in turn how travel demand is likely to be affected by the changing economics. Tymon concurred with that perspective, and both agreed that the longevity of infrastructure necessitates planning for a variety of scenarios, now including the potential impact of autonomous vehicles. New technologies will force planners and citizens to rethink how infrastructure upgrades are planned and financed.

Weinstein Agrawal discussed how electric vehicles could disrupt the current paradigm for public funding. If gas tax revenues then diminish even more rapidly, it would require a new model of transportation infrastructure finance. She noted one such option they have investigated is a mileage fee, which would charge people by the distance they travel each year. People are already becoming familiar with both such trip-based fees, and the privacy

issue given that trips are being tracked, through their experiences with Uber and Lyft. The polling her center has conducted on different transportation pricing options suggests that objections to mileage fees could diminish if people purchase mobility as a service rather than owning their own vehicle and being responsible for all the fees and taxes.

Tymon said that the federal government spends more on infrastructure than the gas tax is able to offset. He noted that while most policymakers agree on the need for infrastructure investment, an ongoing lack of political will on both sides of the political aisle has prevented the gas tax from increasing.

The conversation then focused on the anticipated changes to the ownership structure of vehicles, noting that a shift from private car ownership to ride services may require a new model for user fees to support infrastructure finance. Evaluating the future methods of transportation finance is challenging because it is so difficult to predict how the fleet will evolve.

Weinstein Agrawal noted that restrictions on the ability of municipalities to impose taxes limit flexibility for exploring new options for public finance. California is an example of a state that has high sales taxes, but issues of equity and efficiency arise when states resort to paying for transportation infrastructure by tapping sales tax revenues. Zimmerman and Tymon noted that new personal mobility services can impact public transportation ridership. For example, this has been the case for bike-share programs in the Washington DC area.

Finally, issues raised during the audience Q&A segment included the role of non-governmental organizations in funding local projects, willingness to pay taxes in different mobility ownership scenarios, and the impact of events, crises and price shocks on transportation policy decisions.



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